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## **Do Migrant Students Affect Local Students' Academic Achievements in Urban China?**

Haining Wang\*, Zhiming Cheng<sup>#</sup> and Russell Smyth<sup>^</sup>

### **Abstract**

We examine the educational spillover effects of migrant students on local students' academic achievement in public middle schools in urban China. The identification of peer effects relies on idiosyncratic variation in the proportion of migrant students across classes within schools. We find that the proportion of migrant students in each class has a small, and positive, effect on local students' test scores in Chinese, but has no significant effect on math and English test scores. We also find considerable evidence of heterogeneity in the effects of the proportion of students in the class on local students' test scores across subsamples. Local students toward the bottom of the achievement distribution, local students enrolled in small classes and local students enrolled in lower-ranked schools benefit most in terms of test scores from having a higher proportion of migrant students in their class. Our findings have important policy implications for the debate in China about the inclusion of migrant students in urban schools, and for the assignment of educational resources across schools.

**Keywords:** migrant student; peer effects; academic achievement; China

**JEL classification:** I21

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## 1. Introduction

China has experienced unprecedented internal rural-urban migration, with an increasing number of migrant children moving to urban areas. Based on the 2010 census, more than 20 million rural-urban migrant children aged between 6 and 14 lived in urban areas (Zhang, 2017). In some economically developed regions, migrant students constitute a considerable, and growing, proportion of the share of school-aged children in urban schools, e.g. 46 per cent in Shanghai municipality and 48 per cent in Zhejiang province (Liu et al., 2015). Moreover, China's urban schools will be expected to accommodate increasing numbers of migrant children as internal migration and urbanization continues in the coming decades.

This sharp increase in the number of migrant children in China's urban schools has sparked growing concern among policy makers and the parents of local students about the potential effects of this growth on learning outcomes of local students (Li and Placier, 2015). Specifically, the rapid influx of migrant children, and commensurate changes in class composition, has raised fears that migrant students will be detrimental to the learning and behaviour of local students, as the former are more likely to be socioeconomically and academically disadvantaged (Chen and Feng, 2013). However, recent research has started to question the popular perception that having more migrant students in Chinese urban schools has detrimental learning outcomes. Using data from the 2013 China Education Panel Survey (CEPS) – the same dataset that we use in the present study – Zhao et al. (2017) find that *hukou* status is not a statistical predictor of academic performance in urban schools. These authors suggest that rural-urban migrant students may be highly motivated to achieve academic success because future admission to college is considered to be one of the most effective ways for realizing upward social mobility. Other studies, using other datasets, have reached similar conclusions. Based on data collected in Beijing in 2006–2007, Lu and Zhou (2012) concluded that the academic performance of migrant and local children in public schools was similar. More recently, based on data from the China Family Panel Studies dataset, Xu and Yu (2015) found that migrant children were performing similar to local urban children in terms of educational performance in urban schools.

Table 1 presents data on the class head teachers' and school principals' assessment of the academic foundations of local and migrant students in Chinese, English and math, based on the 2013 CEPS. School principals believed that, in general, migrant students had similar academic foundations to local students in Chinese and math and that migrant students were slightly weaker in English. Class head teachers expressed the view that, in general, local and migrant students exhibited similar academic performance across the three subjects. The actual mean test results among local and migrant students in the 2013 CEPS data, which we discuss later in the paper, also support the views of school principals and head teachers.

### [Table 1]

A large literature on peer effects has shown that educational outcomes are likely to be influenced by the achievement, and behavioural patterns, of peers in the classroom. For instance, inter-student interactions may affect the extent of knowledge spillover, class climate, the amount of effort that students expend on study, student's attitudes to learning and socialising behaviour and the teacher's pedagogical approach and effort in the classroom (Contini, 2013; Hill, 2017). However, relatively little is known about whether, and to what extent, migrant students affect the academic achievement of local students in urban China, despite the importance of this question for education policy and socioeconomic development.

In this study, we use 2013 CEPS data to examine the impact of the proportion of migrant students in the classroom on the educational achievement of local students in middle schools in urban China. To be specific, we examine how the proportion of migrant students in the classroom affects the test scores of local students in Chinese, math and English. We also examine the heterogeneity of migrant peer effects across sub-groups of local students.

There are several challenges associated with the identification of peer effects, including selection, correlation, reflection and separation of endogenous and contextual effects (Manski, 1993; Mora and Oreopoulos, 2011). Selection refers to the endogenous sorting of students across schools and classes. For example, schools may track by ability or segregate low achievers, while parents may endogenously choose the schools to which they send their children. To circumvent this problem, we follow standard practice in the related literature (e.g. Hoxby, 2000; Ohinata and Van Ours, 2013; Schneeweis, 2015) and exploit within-school random variability observed in the share of migrant students across classes. This strategy assumes that changes in the migrant student class share within schools are not correlated with individuals' unobservable characteristics that may be relevant to the educational production process. An advantage of focusing on peer effects at the class level is that students are more likely to interact inside the classroom, and thus the effects are typically stronger than those at the grade or school level (Burke and Sass, 2013). We employ a range of approaches proposed by Ammermueller and Pischke (2009) and Ohinata and Van Ours (2013) to confirm the random formation of classrooms and assignment of educational resources. If there is random assignment across classes, school fixed-effect models provide consistent estimates of the causal effects of class composition (Contini, 2013).

The correlation problem refers to classmates behaving similarly because they are exposed to a common institutional environment, such as similar teacher quality or class environment that may influence students' attainment and behaviour. Failing to account for teacher effects may lead to overestimation of peer effects and even student fixed effects may not be sufficient to alleviate correlated effects bias (Burke and Sass, 2013). To account for common shocks, we control for class and head teachers' characteristics. The existing literature on peer effects in China finds that head teachers have more tools to manage students than do regular teachers and that they have a significant influence on peer effects (Feng and Li, 2016). Including teacher effects also allows us to control for the effects of "teacher shopping" by parents or schools.

The reflection problem occurs if the academic achievements of students and their peers are determined simultaneously, meaning that it is impossible to distinguish the actual causal effect of peers on an individual from the effect of the individual on his or her peers. Following the standard approach in the literature, to minimize the reflection problem, we use a pre-treatment indicator of peer quality – student-assessed difficulty in learning Chinese, English and math at grade six – as a robustness check. One potential concern with this approach is that using the lagged values of peer ability will not completely address the reflection problem if a student also affects his/her peers in a previous period. However, Carman and Zhang (2012) demonstrate that in China there are usually a number of primary schools and high schools in each district. Primary schools randomly assign their students to high schools within the same district. It is reasonable to assume that there is a considerable amount of reshuffling which minimizes overlap between primary and high school classmates. Moreover, we generate student-subject panel data

and use student fixed effects to capture all observed and unobserved subject-invariant student, family and classroom characteristics and other common shocks (Fruehwirth, 2014).

Another difficulty with peer effects estimation is distinguishing between two broad types of social interactions: contextual and endogenous effects. The contextual effect measures the impact of peers' exogenous characteristics and the endogenous effect captures the influence of peers' achievement. These two types of effects are distinct in nature. For instance, the endogenous effect could give rise to bidirectional influence (e.g. in our case, migrant students influence local students, and *vice versa*) and generate multiplier effects (e.g. migrant students influence the performance of local students, which in turn influence the performance of migrant students and so on). The contextual effect, however, will not generate such a multiplier mechanism. Therefore, the isolation of these two effects is important when drawing policy implications. Following Manski (1995) and Gaviria and Raphael (2001), in this study we separate out the contextual effect from the endogenous effect by controlling for contextual characteristics of peers (e.g. family characteristics) to identify the contextual effect.

We find that increasing the class share of migrant students has a significant and positive effect on Chinese test scores of local students, while the effects on math and English test scores are not significant. Increasing the proportion of migrant students by one standard deviation, on average, increases local students' Chinese test scores by 1.52 points, corresponding to an increase of 0.15 standard deviations or 2.17 per cent in mean test scores. We also find strong, and robust, evidence that both endogenous and contextual effects exist in educational performance, and that there are considerable differences across contextual factors. The multiplier effects generated by the endogenous effect range from 1.07 to 1.16, suggesting that a one per cent increase in migrant student class share will eventually lead to a 1.07-1.16 per cent increase in local students' mean test scores. The results of several robustness checks reinforce our general findings and confirm that our approach effectively addresses potential bias due to correlation, reflection, selection and separation of endogenous and contextual effects

We also find that migrant student peer effects operate in a heterogeneous manner. Local students at the bottom of the achievement distribution, local students in small class sizes and local students enrolled in low- and middle-ranked schools appear to benefit most, while those at the middle of the achievement distribution, and those enrolled in high-ranked schools, tend to suffer in terms of their grades from having a higher proportion of migrant peers.

We contribute to the literature on the impact of peer effects on academic achievement in the following ways. First, this is the first study of the peer effects of internal migrant students on local students' educational outcomes in a developing country. Second, we provide representative estimates of peer effects in China by exploiting a nationwide dataset of randomly assigned students within schools. Third, we employ a range of approaches to address the well-known challenges associated with estimating the causal effect of the proportion of migrant students on local students' academic achievements. Moreover, we endeavour to separate out endogenous and contextual effects given that doing so is of great importance to policy implementation and evaluation. Fourth, we further investigate the heterogeneous effects of the proportion of migrant students on academic achievements across subsamples. Fifth, our results help to inform debate in China about the education inclusion of internal migrant students in urban schools, and have strong policy implication for the allocation of migrant students, the composition of classes and the distribution of education resources among schools. Specifically, our results are

important when thinking about class composition because they challenge popular perceptions among the parents of local urban children in China that having a higher proportion of migrant students in the classroom adversely affects learning outcomes of their children.

## **2. Literature review**

Our contribution is related to at least three strands of connected literature. The first is the effects of peer achievement and socioeconomic background on individuals' educational performance (see e.g. Ammermueller and Pischke, 2009; Brunello et al., 2010; Calvó-Armengol et al., 2009; Gibbons and Telhaj, 2008; Lavy et al., 2012b; Lin, 2010; Sacerdote, 2001; Vigdor and Nechyba, 2007; Zimmerman, 2003). Most of the existing literature has attempted to use natural or quasi-experimental settings or fixed effects models to investigate peer effects in the class or grade (Ammermueller and Pischke, 2009; Booij et al., 2017; Lavy et al., 2012b), in dorms (Brunello et al., 2010; Sacerdote, 2001; Zimmerman, 2003) and in military colleges (Carrell et al., 2013; Lyle, 2007). Results from these studies mainly show that while peer effects are significant, they are rather small and highly context specific. A one standard deviation increase in peer performance is associated with less than 10 per cent growth in educational achievement. In addition, peer effects might be nonlinear and vary considerably across fields of study (Brunello et al., 2010) and ability levels (Ahn and Trogdon, 2017; Feld and Zölitz, 2017).

The second strand of literature, to which our study is more closely related, is the effect of peer group composition in the class or grade on educational achievement and behaviour (Bui, 2014; Carrell and Hoekstra, 2010; Gaviria and Raphael, 2001; Hill, 2017; Hoxby, 2000; Lavy et al., 2012a; Lavy and Schlosser, 2011; Mora and Oreopoulos, 2011). Most existing studies find evidence that peer gender effects significantly effect educational achievement, major choice, graduation rates and engagement in risky behaviour, with the effects on male students being a little larger (Fischer, 2017; Hill, 2017; Horoi and Ost, 2015; Hoxby, 2000; Lavy and Schlosser, 2011; Sacerdote, 2011). The underlying mechanism is that a higher proportion of female students might lower the level of classroom disruption, improve inter-student and student-teacher relationships, and lessen teachers' fatigue (Borjas, 2004). A subset of this literature investigating racial group and ability composition effects typically finds that increasing the fraction (number) of black, low-ability or delinquent students has a significant detrimental effect on academic outcomes (Ballatore et al., 2015; Betts, 1998; Horoi and Ost, 2015; Hoxby, 2000; Jensen and Rasmussen, 2011; Lavy et al., 2012a).

The third strand of literature, and that to which our study is the most closely related, is the literature on educational spillover effects between immigrant and native students. Existing studies present mixed evidence, finding that the concentration of immigrant students has a weak negative impact on natives' educational outcomes (Ballatore et al., 2015; Borjas, 2004; Contini, 2013; Jensen and Rasmussen, 2011), no sizeable effects (Geay et al., 2013; Ohinata and Van Ours, 2013), or even a positive impact on the likelihood of university enrolment and achievement (Fekjær and Birkelund, 2007). Most studies have found small, but significant, negative spillover effects of immigrant students on test scores of natives in elementary and secondary schools and universities in developed countries (Brunello and Rocco, 2013; Contini, 2013; Jensen and Rasmussen, 2011; Tonello, 2016). Generally, increasing the share of immigrants by one percentage point leads to a 0.043-0.67 per cent decrease in native peers' mean test scores. This negative effect varies substantially by gender, discipline, socioeconomic background and immigrants' language at home. Findings from previous studies suggest that immigrant peer

effects are more pronounced for females and students with low socioeconomic background (Brunello and Rocco, 2013; Contini, 2013). Jensen and Rasmussen (2011) and Tonello (2016) find that a high concentration of immigrant students in schools is negatively associated with reading and language test scores, while the effects on math test scores are inconsistent.

While there is a vast literature on the relationship between immigrant class share and educational performance of native students in developed countries, there is limited evidence on peer effects in developing countries (see e.g. Duflo et al. (2011) for Kenya. Bobonis and Finan (2009) for Mexico and Ahmed and Arends-Kuenning (2006) for Bangladesh). Research on the educational spillover effects of peers in China is even more limited. Feng and Li (2016) estimate peer effects at the class level in a Chinese middle school. They find that peer effects have a significant, and negative, effect on students test scores, while head teachers, who have more tools to manage students than regular teachers, can generate positive peer effects.

Carman and Zhang (2012) identify peer effects for math, English and Chinese test scores separately by using a panel dataset from a middle school in China. They address the potential self-selection problem and common teacher effects by controlling for both individual and teacher-by-test fixed effects. Their results suggest that lagged peer performance has a significant and positive effect on math test scores, but no effect on English and Chinese test scores. However, as highlighted by Clotfelter et al. (2006), including student fixed effects could exacerbate problems stemming from non-random assignment of teachers to classrooms, which might lead to substantial overestimation of peer effects. This view is supported by Hanushek et al. (2003) who find a large increase in the estimated peer coefficient when controlling for individual fixed effects. Ding and Lehrer (2007) use a dataset from secondary schools in one county in Jiangsu province to investigate the association between peer performance and student academic achievement. They find strong evidence for the existence of positive peer effects and that reducing variation in peer ability could significantly increase student achievement. Both studies for China suggest that peer effects operate in a heterogeneous manner, and that medium-ability or high-ability students tend to benefit more from better peers. However, each of the studies on peer effects in China are restricted to a particular school or schools in one county. Whether their findings can be generalised remains an open question.

### **3. Data**

The data used in this study is from CEPS, administrated by the National Survey Research Center at Renmin University of China. The CEPS is a large-scale, nationally representative survey that employs a stratified, multistage sampling design with a probability proportional to size sampling method. Each subsample in the CEPS is drawn through three stages: county (or district), then school, and then classes.<sup>1</sup> The baseline survey, conducted during the 2013-2014 academic year, covers 19,487 seventh and ninth graders in 438 classes across 112 middle schools in 28 counties/districts in mainland China. CEPS collects information on students, their parents, head teachers, main subject teachers and school principals. Information collected covers demographics, migration status, transcripts of important examinations, in-school performance, and a wide range of family, classroom and school characteristics.

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<sup>1</sup> Two classes were randomly selected for each grade at each selected school.

We restrict our sample to ninth grade students in public schools in urban China for two reasons. First, findings from previous studies on China suggest that older adolescents are more susceptible to peer influence (Li et al., 2013; Nie et al., 2015). Second, students in elementary schools are usually randomly reshuffled into different middle schools in the same districts (Carman and Zhang, 2012).<sup>2</sup> Therefore, students in the ninth grade are more plausibly influenced by social interactions in the surveyed classes than those in the seventh grade. To ensure that class assignment was random, based on two survey questions in the principals' questionnaire, we further restrict our sample to schools in which principals confirmed that students were randomly assigned at the time of entry into middle school and that no reassignment subsequently occurred. In the final sample employed, there are 3,462 students in 85 classes across 43 middle schools; of which 2,875 are local students (83.04 per cent) and 587 are migrant students (16.96 per cent). The average proportion of migrant students in each class is 20.23 per cent (S.D.: 0.17).

Students' academic achievement is measured by Chinese, math and English test scores in the mid-term examination taken in the autumn of 2013. To facilitate comparison across subjects, these scores are standardized to a mean of 70 and a standard deviation of 10. In addition to test scores, as a robustness check, we also examine the effect of migrant student class share on three more comprehensive, albeit subjective, measures of students' achievement: student assessment of their own score rank in class (SSR), parent-assessment of their child's score rank in class (PSR) and parent-assessment of their child's learning attitude (PLA). The three indicators are measured on a five-point Likert scale (1=very low/half-hearted; 5=very high/earnest).

The summary statistics, as shown in Table 2, suggest that, relative to migrant students, local students have relatively higher math and English test scores, but lower Chinese test scores. That migrant students perform better in Chinese than local students might seem surprising, given that many migrant students will speak their local dialect as their first language. This finding, however, is consistent with what has been found in other surveys. For instance, interviewers for the Chinese Family Panel Studies also observed that migrant children had better Chinese language skills than urban children (Xu and Yu, 2015). The average self-assessed score rank assessed by local students is higher than that of migrant students, which is consistent with their parents' assessments. Moreover, as assessed by their parents, local students have a more positive attitude towards learning than migrant students. Table A1 in the Appendix presents the definitions and summary statistics for variables used in this study.

[Table 2 here]

#### 4. Econometric methods

We investigate the effect of the share of migrant students on local students' academic achievement by estimating the following reduced form education production function:

$$Y_{ics} = \alpha + \beta MS_{cs} + \gamma P_{ics} + \delta C_{cs} + \theta S_s + \mu_{cs} + \varepsilon_{ics} \quad \dots\dots(1)$$

where subscript  $i$  denotes the individual,  $c$  denotes the class and  $s$  represents the school.  $Y_{ics}$  denotes the Chinese, math or English test scores or the SSR, PSR or PLA of the  $i$ th student in

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<sup>2</sup> For more detailed discussion on the class assignment procedure, see Carman and Zhang (2012) and Feng and Li (2016).



class  $c$  of school  $s$ , depending on the exact empirical specification.  $MS_{cs}$  is the main variable of interest, which is defined as the proportion of migrant students in class  $c$  of school  $s$ . The estimated peer effects  $\beta$  reflect a combination of endogenous and contextual effects.

Of the control variables,  $P_{cs}$  is a vector of personal characteristics, including demographic characteristics, student behaviour in school, family background and the degree of parents' interest in their child's study. In addition, we include student-assessed difficulty in learning the three subjects in the sixth grade, in order to proxy for the stock of education attainment. We also include variables measuring the student's cognitive ability,<sup>3</sup> self-confidence and opinions on whether they find each of the three subjects useful, that seek to at least partly capture unobservable characteristics.  $C_{cs}$  is a vector of classroom characteristics that control for potential correlated effects, including class rank, class size and head teacher's personal characteristics.  $S_s$  is a school fixed effect that controls for the endogenous sorting of students across schools.  $\mu_{cs}$  and  $\varepsilon_{cs}$  are class level and individual level error terms, respectively.

Given the potentially high correlation in terms of performance between Chinese, math and English test scores, we use seemingly unrelated regression (SUR) to simultaneously estimate the effects of the fraction of migrant students on the three test scores.

Our identification strategy, conditional on school fixed effects, is based on students being randomly assigned to classes within schools. We employ a variety of strategies to examine whether classes were formed randomly and whether different classes systematically obtained different educational resources. First, following Ammermueller and Pischke (2009), we perform a series of Pearson  $\chi^2$  tests to check whether classes are formed randomly with respect to five specific observed student characteristics; namely, migration status, gender, age, cognitive ability or family's economic status. Table 3 reports the  $p$ -values of tests for each of these five student characteristics. Given that all  $p$ -values are well above the 5 per cent level, we are unable to reject the null hypothesis of random allocation of students to classes.

[Table 3 here]

Second, we employ the approach proposed by Ohinata and Van Ours (2013) to test whether there is endogenous sorting of migrant students across classes within a school. To do so, we first predict the distribution of the expected numbers of schools with  $d=1, \dots, D$  difference in the number of migrant students between two classes within the same school, assuming that students are randomly allocated to each class. Then, we compare the simulated distribution of schools with the actual distribution. If migrant students are indeed randomly assigned to classes, we will see that the two distributions are similar to each other.

The simulated and actual distributions of migrant students in schools are plotted in Figure 1. We can see that the two distributions are generally identical. An Epps–Singleton two-sample test ( $p$ -value=0.83) suggests that there is no significant difference between these two distributions, meaning that the assignment of migrant students across classes is random.

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<sup>3</sup> The CEPS conducted a standardized cognitive ability test for each student based on the three-parameter logistic (3PL) model. The cognitive ability test score is widely used in the labour and health economics literature as an independent variable to tease apart the influence of cognitive ability and other factors.

[Figure 1 here]

Third, we test whether the assignment of educational resources is random across classes. Even if class composition is random, allocation of educational resources, especially teachers, may differ in systematic ways. For instance, a school may assign better/worse teachers to the class that ends up with more lower-ability students purely by chance. If so, more informed parents may be able to place their children in the class with better teachers. In China's middle schools, teachers' wage and bonus are highly correlated with the achievements of the students that he/she teaches. Thus, teachers, and in particular higher-ability teachers, may have stronger economic incentives to avoid assignment to classes with more lower-ability students. Non-random assignment of educational resources would bias estimates of peer effects.

To shed light on this potential problem, we check whether class migrant composition, gender composition, mean age and mean pre-treatment abilities (i.e. average student-assessed difficulties in learning Chinese, math and English at sixth grade) are related with the characteristics of head teachers, students' family background, class rank and class size. The results in Table 4 show that these correlations are all insignificant conditional on school fixed effects, except for the association between gender composition and family economic status and between head teacher's education and student's pre-treatment abilities. However, the magnitude of these two correlations are relatively small. A one standard deviation increase in family economic status is associated with a 6 per cent decrease in the proportion of male students. A one standard deviation increase in the proportion of head teachers with postgraduate education or above is only associated with a 0.04 points increase in pre-treatment abilities.

[Table 4 here]

Taken together, all three tests present strong evidence that class composition in our sample are formed randomly within schools, particularly with respect to migration status, and that educational resources are also assigned in a roughly random manner.

## 5. Empirical results

### 5.1 Migrant student peer effects and academic achievements

We first examine the spillover effects of migrant students on local students' educational performance. Table 5 presents ordinary least squares (OLS) and SUR estimates of the effect of the proportion of migrant students in class on local students' test scores, score rank and attitudes to learning. We cluster the standard errors at the class level. In the SUR model, the correlation coefficients ( $\text{atanh } \rho$ ) between any two of the three subjects are positive and significant, rejecting the null hypothesis that there is no correlation between the error terms.

[Table 5 here]

The results show that the proportion of migrant students in the class has a positive and significant effect on local students' Chinese test score, after controlling for other factors potentially correlated with test scores, while the effects on math and English test scores are not significant. This effect can be interpreted as the result of the cumulated externalities experienced by local students from exposure to migrant students, mostly in the first two years in middle school. Our results for Chinese test scores are in line with previous findings from developed countries that immigrant peers have a positive, although small, effect on natives' grades, graduation rates and university enrolment rates (Bui, 2014; Fekjær and Birkelund, 2007;

Hunt, 2016). The results are also consistent with previous studies that peer effects exhibit differences across subjects and majors (Brunello et al., 2010; Carman and Zhang, 2012; Zimmerman, 2003) and that educational spillover effects are more strongly correlated with verbal or language test scores than with math test scores (Contini, 2013; Tonello, 2016; Zimmerman, 2003). Moreover, given that migrant students' Chinese test scores are higher than that of local students as shown in Table 2, our results are consistent with a large body of literature that finds positive spillover effects from high-achievers to those who *ex ante* do not perform as well (Burke and Sass, 2013; Ding and Lehrer, 2007; Feld and Zölitz, 2017).

The magnitude of the estimated peer effects suggests that a one standard deviation increase in the proportion of migrant students (a 17 per cent increase) is associated with 1.52 points increase in Chinese test scores, corresponding to an increase of 0.15 standard deviations or 2.17 per cent in mean test scores. To put the magnitude of this peer effect in context, it is equivalent to a change in class size by about 8 students or 0.43 standard deviations improvement in local students' cognitive ability. The size of peer effects estimated in the previous literature ranges from close to zero to approximately 0.5 for a one standard deviation change in the peer measure (Ammermueller and Pischke, 2009). The size effect for migrant student class share in the present study falls within this range and is very close to the estimates reported in previous studies. For example, Contini (2013) finds that increasing the class share of immigrant students by 10 percentage points would decrease the test score of an individual in sixth grade by about 1 point. Ammermueller and Pischke (2009) find that a one standard deviation change in the average number of books in peers' homes generates a 0.17 standard deviation change in reading test scores. The size of the estimated peer effects in our study is lower than in Carman and Zhang's (2012) study for China, who find that a one standard deviation increase in the average peer math test score generates an increase of 0.4 standard deviations in student grades.

We follow the strategy employed in previous studies (Gaviria and Raphael, 2001; Li et al., 2013; Manski, 1995) and use migrant students' family economic status and parental educational attainments to capture the contextual effect. We find strong evidence for the existence of both endogenous and contextual effects and considerable differences in the contextual effect in Table 6. The effect of the proportion of migrant students on local students' math and English test scores becomes significant when a set of migrant students' family background characteristics is included in the specification, while the magnitude of the estimated effects is almost identical to that reported in Table 5. Increasing the migrant student class share by one standard deviation is associated with an increase of 1.89, 1.35 and 0.85 points in local students' Chinese, math and English mean test scores, respectively. Following the method proposed by Bobonis and Finan (2009), we calculate the multiplier effects generated by the endogenous effect to be in the range 1.07 to 1.19. This suggests that a one per cent increase in the proportion of migrant students will eventually lead to a 1.07-1.19 per cent increase in local students' mean test scores. We find significant positive effects of migrant students fathers' education on the math test scores of local students. A one standard deviation increase in migrant students fathers' education raises local students' math test scores by 1.11 points. This result suggests that migrant students' family backgrounds influence local students' behaviour indirectly. However, migrant students' family economic status has no significant spillover effects on local students' test scores.

[Table 6 here]

### *5.2 Robustness checks*

In this section, we employ a series of tests to check the robustness of our main findings. First, in addition to the test scores, we examine the effect of the proportion of migrant students on three alternative measures of educational achievement: SSR, PSR and PLA. The OLS estimates for these indicators are reported in the last three columns of Table 5. The findings suggest that the proportion of migrant students in a class has a significant and positive association with SSR, PSR and PLA, which is in line with the estimates for peer effects on test scores. A one standard deviation increase in migrant student class share is associated with nearly a 0.17 points increase in student- and parents-assessed score rank and parents-assessed learning attitude.

Next, we replace the migrant student class share with the number of books in migrant students' homes (scale: 1=very few books; 5=many books), a variable similar to that used by Ammermueller (2005) to examine peer effects in European primary schools. The number of books at home is highly correlated with parental earnings and educational attainment, and is one of the most important predictors of reading skills among various family background variables (Woessmann, 2004). The results in Table A2 show that a one standard deviation increase in the number of books in migrant students' homes leads to a 0.19 standard deviation increase in local students' Chinese test scores, and this estimate is marginally significant. The effect size of our estimate is very close to that reported in Ammermueller (2005).

To check whether the estimated peer effects are confounded by correlated effects, we perform a falsification test. We randomly assign students from other classes of the same school to be each local student's peers, and then examine the effects of falsified migrant student class share and their family background on local students' test scores. The results of this exercise are reported in Table A3. The results show that the proportion of migrant students, their family economic status and parents' education all have no significant effects on local students' Chinese, math and English test scores. Moreover, the signs of these estimates are not consistent across subjects. The findings from the falsification exercise provides strong evidence that the estimated peer effects in Table 6 are not a response to a common institutional environment.

To address the reflection problem, we use the student-assessed learning difficulty in the three subjects in sixth grade as a pre-treatment indicator of migrant students' learning quality. In Table 5 this measure is shown to be one of the best predictors of student performance. In addition, following Feng and Li (2016), we construct a student-subject panel dataset and use student fixed effects regression to control for all subject-invariant variables, including observed and unobserved student, family and class characteristics. This approach further ensures that our estimates are free of confounding factors. We also control for local students' opinion of the usefulness of the three subjects, student-assessed difficulty in learning the three subjects at sixth grade and subject teachers' characteristics in the regression. The results, which are reported in Table A4, show that average lagged migrant students' educational performance has a significant positive effect on local students' test scores. This result reaffirms our above findings.

### *5.3 Heterogeneity in peer effects*

There is increasing evidence that peer effects vary by student ability, gender and family socioeconomic status. In this section, we further investigate the potential heterogeneous effects of migrant student class share on local students' test scores across subsamples.

Table 7 presents the SUR estimates of migrant student peer effects across the achievement distribution, gender, class size, school rank and level of parental education. We find that local students with low Chinese test scores are positively affected by having a higher proportion of migrant students in their class, while those with middle-range English test scores appear to experience a significant, and negative, impact from having a higher proportion of migrant peers. The magnitude of the estimated effect on English test scores is slightly weaker. Increasing the migrant student class share by one standard deviation only decreases local students' English test scores by 0.85 points. This result is in line with the findings from the previous literature that students usually benefit from having high-achieving peers while their results are harmed from having lower-ability peers, and that lower-ability students seem to benefit/suffer by a larger margin than do middle and higher ability students (Burke and Sass, 2013; Feng and Li, 2016; Lavy et al., 2012a). However, we find no significant association between the fraction of migrant students and the test scores of high-ranked local students. One plausible explanation for this result is that while, on the one hand, high-ability local students are relatively isolated from migrant students and are more likely to have a lower level of social interaction with their migrant peers, on the other, high-ability local students have less room for improvement in academic achievement.

[Table 7]

We find that the presence of migrant students generates positive and significant externalities on both male and female local students' Chinese test scores. Males are more susceptible to the influence of migrant peers than females. This finding is consistent with previous studies that have also found stronger peer effects on males' educational performance or behaviour (Griffith and Rask, 2014; Hill, 2017; Tonello, 2016). Our results likely reflect that male students might exhibit less discriminatory attitudes or prejudice towards migrant peers and are more willing to communicate with them. This conjecture is supported by the fact that male students reported having a slightly higher proportion of migrant friends in the 2013 CEPS.<sup>4</sup>

The existing literature suggests that social interactions are likely to be influenced by class size. Our results show that the proportion of migrant students has a positive and significant effect on the Chinese test scores of local students in small classes, while the effect in large classes is not significant, suggesting that social interaction in small classes are more intensive. This result is consistent with previous studies that find stronger peer effects of non-native students on natives' educational outcomes in small classes and gender peer effects on males' cognitive outcomes in small schools (Lavy and Schlosser, 2011; Tonello, 2016).

We also find that the migrant student class share has a significant and positive effect on local students' Chinese test scores in low-ranked schools and math and English test scores in middle-ranked schools. In the CEPS sample, the standard deviation of three test scores in low and middle-ranked schools is 9.93, while that in high-ranked schools is 9.95. Therefore, one possible explanation for this finding is that migrant and local students in low- and middle-ranked schools tend to have similar educational achievements. Findings from previous studies have suggested that students seem to benefit more from having homogeneous peers, because teachers

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<sup>4</sup> For male local students, 14 per cent of their best friends are migrant students. For female local students, 12 per cent of their best friends are migrant students.

can better tailor their pedagogical practices to the classroom composition (Duflo et al., 2011; Hoxby and Weingarth, 2005). In contrast, local students' English test scores in high-ranked schools are negatively associated with the proportion of migrant students. This result is consistent with previous findings that students may suffer from negative educational externalities in the presence of low ability peers, given that the English test scores of migrant students are much lower than that of local students in high-ranked schools.

Finally, we examine whether the effect of the proportion of migrant students differs by parental education of local students. The results show that the proportion of migrant students has a stronger and positive effect on the Chinese and English test scores of local students with higher parental education. This may imply that educated parents could reinforce the positive spillover effects of migrant students through having higher aspirations and expectations for their children's education and future as well as assisting them with study (Brown and Park, 2002).

## **6. Conclusion**

We have examined the educational spillover effects of migrant students on local students' academic achievement in middle schools in urban China. To address the endogenous sorting of students across schools, we identify peer effects by exploiting within-school idiosyncratic variation in the proportion of migrant students across classes. We employ a variety of strategies to confirm that the formation of classroom and assignment of educational resources are random. We find that the fraction of migrant students has a positive and small effect on local students' Chinese test scores, but no significant effect on math and English test scores. Our results provide strong evidence for the existence of both endogenous and contextual effects, and that the latter exhibits considerable differences across student circumstances. Among the contextual variables, migrant student's family economic status and mother's education have a negative, while father's education has a positive, spillover effects on local students' Chinese and math test scores. We conduct several robustness checks to address the potential reflection problem and bias from correlated effects and the results confirm our general findings.

There is considerable heterogeneity in the effects of migrant student class share on local students' test scores across subsamples. This might reflect that peer effects are generated by mechanisms that highly depend on the specific context. Students with low Chinese test scores appear to benefit from, while those with middle English test scores are disadvantaged by, having a higher proportion of migrant peers. High ability local students are relatively isolated from migrant students and thus are not likely to be affected by the presence of migrant students. Male students and those in small classes are more susceptible to the influence of migrant peers than females and those in large classes respectively. This may reflect more intensive social interactions between local males and migrant students and among students in small classes.

We also find that the migrant student class share has a positive effect on local students' Chinese test scores in low-ranked schools and math and English test scores in middle-ranked schools, while it has a negative effect on English test scores in high-ranked schools. One potential explanation for this finding is that migrant and local students in low- and middle-ranked schools exhibit similar educational achievement. Both of them could benefit from classroom homogeneity, as teachers can better tailor their instruction to students' ability. We also observe a stronger, and positive, effect of having migrant student peers on the Chinese and English test scores of local students who have better educated parents, which suggests that better educated

parents reinforce positive spillover effects through having higher expectations for their children's future and being better placed to assist their children with study.

Our main conclusions have important policy implications for debate in China about the education inclusion of internal migrant students in urban schools. The increase in the number of migrant children in urban cities has raised the fear of both local governments and parents that migrant students will compete for scarce educational resources and that this might be detrimental to the learning outcomes and behaviour of local students. However, findings from this study suggest that the concentration of migrant students in urban middle schools should not be an issue of concern, as a higher proportion of migrant students in class overall has a positive, rather than detrimental, effect on local students' academic achievement. Therefore, the Chinese central and local governments should invest more in the educational inclusion of migrant students through increasing financial support for low- and middle-ranked schools, and relaxing institutional restrictions on migrant students' enrolment in urban middle schools.

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**Table 1 Assessment of local and migrant students by school principals and class head teachers, 2013 China Education Panel Survey**

	Mean	S.D.
<b>Panel A: school principal</b>		
Compared to local students, how were the academic foundations of migrant students when they entered your school? (scale: 1=much worse; 2=worse; 3=similar; 4=better; 5=much better)		
Chinese	2.76	0.54
Math	2.78	0.59
English	2.39	0.79
<b>Panel B: class head teacher</b>		
Compared to local students, how are the academic foundations of migrant students? (scale: 1= worse; 2=similar; 3=better)		
Chinese	2.02	0.45
Math	2.00	0.54
English	1.86	0.58

**Table 2 Summary statistics for subject test scores, score ranks and learning attitude**

	Local students		Migrant students	
	Mean	S.D.	Mean	S.D.
Chinese score	69.95	9.92	70.23	10.05
Math score	70.06	9.95	69.71	9.86
English score	70.08	9.96	69.57	9.82
Student-assessed score rank	3.04	1.14	2.97	1.13
Parents-assessed score rank	3.08	1.07	3.05	1.02
Parents-assessed learning attitude	3.34	0.99	3.29	0.94

Note: subject test scores are standardized to a mean of 70 and a standard deviation of 10.

**Table 3 Pearson  $\chi^2$  tests for the independence of migrant student's proportion and class assignment**

	<i>p</i> -value
Migration status	0.2183
Gender	0.7785
Age	0.4081
Students' cognitive ability	0.1206
Family economic status	0.1198

**Table 4 Balancing test for assignment of class resources**

	Proportion of migrant students	Ratio of male students in class	Students' mean age in class	Average family economic status of all students' families	Average learning difficulties at the 6 <sup>th</sup> grade for all students
<i>Head teacher's characteristics</i>					
Male head teacher	-0.0173 (-0.53)	-0.0082 (-0.19)	0.0407 (0.71)	-0.0222 (-0.40)	-0.0789 (-0.91)
Education of head teacher (ref: graduate diploma)					
Bachelor – continuing higher education	0.0551 (0.99)	0.0529 (1.16)	-0.0704 (-0.56)	0.0311 (0.41)	0.0535 (0.41)
Bachelor – general (full-time) higher education	0.0489 (0.98)	0.0195 (0.55)	-0.0936 (-0.78)	0.0062 (0.09)	0.0894 (0.64)
Postgraduate qualification	-0.1734 (-1.17)	-0.1177 (-0.97)	-0.0410 (-0.25)	-0.0145 (-0.10)	-0.2381** (-2.09)
Teaching experience of head teacher	0.0023 (0.63)	-0.0018 (-0.69)	-0.0022 (-0.74)	-0.0020 (-0.50)	0.0058 (1.19)
<i>Class characteristics</i>					
Class rank	-0.0055 (-0.17)	-0.0177 (-0.91)	0.0110 (0.41)	-0.0003 (-0.01)	0.0136 (0.26)
Class size	0.0136 (0.67)	-0.0072 (-0.51)	0.0287 (1.44)	0.0311 (1.01)	0.0256 (1.19)
Class size squared	-0.0001 (-0.63)	0.0000 (0.08)	-0.0003 (-1.08)	-0.0004 (-1.08)	-0.0000 (-0.25)
Average years of education of all student's parents	-0.0196 (-0.70)	-0.0195 (-0.79)	-0.0701 (-1.54)		
Average family economic status of all students' families	0.0560 (0.26)	-0.2959* (-1.74)	-0.0115 (-0.07)		
Constant	0.0255 (0.04)	1.9749*** (4.18)	15.6414*** (19.55)	2.5075*** (4.64)	2.7828*** (6.80)
School fixed effects	Yes	Yes	Yes	Yes	Yes
<i>N</i>	84	84	84	84	84
adj. <i>R</i> <sup>2</sup>	0.7702	0.4796	0.9747	0.7444	0.7889

Notes: *t* statistics in brackets; \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

**Table 5 Estimates of the effects of the proportion of migrant students on local students' academic achievements and learning attitude**

	SUR			OLS		
	Chinese	Math	English	SSR	PSR	PLA
Proportion of migrant students	8.9354** (2.06)	4.1367 (1.15)	2.2146 (1.02)	1.0126*** (3.48)	1.0065*** (3.97)	0.9158*** (2.78)
Learning difficulties at sixth grade	1.7674*** (8.02)	1.9434*** (11.16)	2.0833*** (13.48)	0.0903*** (7.10)	0.0970*** (8.85)	0.0334*** (3.50)
Male	-3.8572*** (-10.08)	-1.2167*** (-3.04)	-3.2833*** (-8.74)	-0.0748* (-1.77)	-0.1501*** (-3.56)	-0.3149*** (-6.71)
Age	-0.3079 (-1.03)	-0.1795 (-0.62)	-0.0484 (-0.15)	0.0212 (0.61)	0.0535* (1.79)	0.0408 (1.09)
Agricultural <i>hukou</i>	1.2290* (1.93)	0.6240 (1.23)	0.8964* (1.67)	0.0143 (0.24)	0.1061* (1.68)	0.1094** (2.14)
Health	0.0250 (0.12)	-0.0414 (-0.22)	0.0081 (0.05)	-0.0030 (-0.12)	0.0133 (0.57)	0.0360 (1.60)
Ability	3.9766*** (14.81)	4.7348*** (16.45)	4.1225*** (16.91)	0.4663*** (15.32)	0.4309*** (15.11)	0.1964*** (7.15)
Confidence	1.0557*** (3.44)	1.3322*** (5.42)	1.5045*** (6.34)	0.2973*** (9.97)	0.2244*** (7.20)	0.1979*** (6.17)
Opinions on subjects	1.0378*** (4.99)	0.9145*** (5.90)	1.1006*** (7.50)	0.0561*** (5.14)	0.0489*** (4.33)	0.0561*** (4.71)
Extracurricular	-1.3142*** (-3.14)	-1.3097*** (-3.46)	-1.0258** (-2.55)	-0.1251*** (-2.74)	-0.1101*** (-2.83)	-0.0879* (-1.93)
Late for class	-0.2360 (-0.64)	-0.3810 (-1.30)	-0.2559 (-0.86)	-0.1031*** (-2.71)	-0.0661** (-2.03)	-0.1336*** (-3.43)
Skip class	-0.5749 (-1.04)	-0.6703 (-1.51)	-0.3380 (-0.71)	-0.0934 (-1.56)	-0.0740 (-1.34)	-0.0895 (-1.61)
Family economic status	0.1372 (0.33)	-0.1699 (-0.49)	-0.1496 (-0.34)	0.0184 (0.42)	0.0338 (0.79)	0.0402 (0.84)
No. of sibling	0.2516 (0.72)	-0.1587 (-0.53)	-0.1521 (-0.43)	0.0182 (0.50)	0.0189 (0.54)	0.0456 (1.23)
Mother's education	0.1152 (1.28)	0.1104 (1.47)	0.1020 (1.39)	0.0211** (2.34)	0.0292*** (3.53)	0.0190** (2.16)
Father's education	0.2759*** (3.51)	0.1535* (1.87)	0.1669** (2.07)	0.0247** (2.41)	0.0223** (2.29)	0.0096 (1.02)
Parental strictness with exam	0.4628 (1.19)	0.2245 (0.70)	-0.3110 (-0.84)	-0.0109 (-0.26)	-0.0298 (-0.78)	-0.0387 (-0.96)
Parental strictness with behaviour	-0.9524** (-2.53)	-0.9530*** (-2.89)	-0.4668 (-1.53)	-0.1047*** (-2.93)	-0.0755** (-2.04)	0.0187 (0.48)
Class rank	1.2222*** (3.79)	0.3850 (0.94)	0.4278 (1.17)	-0.0032 (-0.11)	0.0259 (1.19)	0.0608** (2.52)
Class size	0.1825*** (3.45)	0.3024*** (4.71)	0.2094*** (3.29)	-0.0110* (-1.79)	-0.0054 (-0.98)	0.0140* (1.98)
Male head teacher	-1.0375** (-2.24)	-1.6404*** (-2.83)	-1.4120** (-2.30)	0.0669 (1.47)	0.0891** (2.12)	0.0421 (0.78)
Education of head teacher (ref: graduate diploma)						
Bachelor – continuing higher education	1.0923 (0.96)	-3.8250*** (-3.22)	-0.4795 (-0.69)	-0.0616 (-0.59)	-0.1505 (-1.41)	-0.1576* (-1.67)
Bachelor – general (full-time) higher	1.6608 (1.48)	-1.7436 (-1.36)	-0.0432 (-0.06)	-0.1328 (-1.26)	-0.1716 (-1.66)	-0.0067 (-0.08)

education						
Postgraduate qualification	1.6116 (1.12)	1.6588 (0.86)	4.4445*** (2.93)	-0.1305 (-0.52)	0.2535*** (2.80)	0.1709 (1.29)
Teaching experience of head teacher	0.0390 (0.91)	0.0855 (1.61)	0.1316*** (4.08)	-0.0013 (-0.36)	-0.0001 (-0.02)	0.0014 (0.45)
Age of head teacher	-0.0373** (-2.05)	-0.0583** (-2.05)	-0.0810*** (-3.64)	0.0018 (0.78)	0.0010 (0.51)	0.0013 (0.57)
Constant	47.1455*** (8.20)	47.9318*** (7.11)	45.8405*** (7.34)	0.3509 (0.56)	-0.6500 (-1.17)	0.4195 (0.68)
atanh $\rho$	0.6446***	0.6756***	0.7116***			
1_2/1_3/2_3	(18.40)	(17.74)	(18.41)			
School fixed effects	Yes			Yes	Yes	Yes
<i>N</i>	2520			2479	2369	2370
Log likelihood/ adj. <i>R</i> <sup>2</sup>	-24981.51			0.3031	0.2839	0.2247

Notes: *t* statistics in brackets; \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; results on school fixed effects are available from the authors.

**Table 6 SUR estimates of peer effects: proportion of migrant students and migrant students' family background**

	Chinese	Math	English
Proportion of migrant students	11.1169** (2.54)	7.9515** (2.42)	5.0272** (2.31)
Average father's education among migrant students	0.0801 (0.51)	0.5167*** (3.95)	0.0994 (0.71)
Average family economic status among migrant students	1.0417 (0.67)	0.3837 (0.44)	0.7560 (0.62)
<i>N</i>	2213		
Log likelihood	-21900.167		

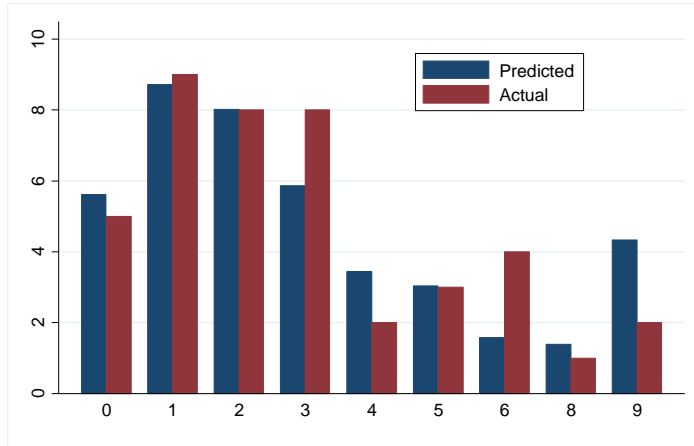
Notes: *t* statistics in brackets; \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; all specifications include control variables and school fixed effects; results are available from the authors.

**Table 7 SUR estimates of heterogeneity in peer effects**

	Chinese		Math		English	
<b>Panel A: by score level</b>						
Low	8.7606**	(2.29)	-2.1411	(-0.58)	-1.2550	(-0.45)
Middle	3.8154	(0.90)	4.0517	(1.10)	-4.9904**	(-1.97)
High	2.0393	(0.48)	-1.0781	(-0.28)	-2.7143	(-0.95)
<b>Panel B: by gender</b>						
Female	8.6134*	(1.90)	5.4391	(1.52)	2.8010	(1.29)
Male	9.2524**	(2.04)	2.9418	(0.71)	1.6684	(0.61)
<b>Panel C: by class size</b>						
≤45 students	9.6106**	(2.28)	4.4226	(1.25)	2.2368	(1.00)
>45 students	-3.8750	(-1.46)	-1.6165	(-0.47)	-0.1610	(-0.03)
<b>Panel D: by school rank</b>						
Low	15.4142***	(3.40)	-2.6664	(-0.69)	5.4943	(1.45)
Middle	6.8336	(1.02)	10.5284**	(2.07)	9.1989***	(3.47)
High	10.4466	(1.46)	-4.1094	(-0.83)	-9.9194**	(-2.14)
<b>Panel E: by parental education</b>						
≤9 years	7.1474*	(1.68)	1.7055	(0.45)	-2.3418	(-0.82)
>9 years	9.5547**	(2.15)	4.9933	(1.34)	3.7562*	(1.66)

Notes: *t* statistics in brackets; \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; all specifications include control variables and school fixed effects; results are available from the authors.

**Figure 1 Predicted and actual differences in number of migrant students between two classes within the same school**





## Appendix

**Table A1 Summary statistics for independent variables**

Variable	Definition (and scale)	Mean/ percent	S.D.
<i>Local students' characteristics</i>			
Male	Reference: female	50.51%	
Age	Years	14.95	0.93
Agricultural <i>hukou</i>	Non-agricultural <i>hukou</i> = 0 (reference group); agricultural <i>hukou</i> = 1	38.59%	
Health	Self-rated health status (very unhealthy=1; very healthy=5)	4.05	0.89
Ability	Standardized score for cognitive test based on the three-parameter logistic (3PL) model	0.18	0.89
Confidence	Self-confidence in the future (not confident at all=1; very confident=5)	3.17	0.74
Opinions on subjects			
Opinion on maths	Very helpful = 1, very helpful = 4	3.00	0.88
Opinion on Chinese	Very helpful = 1, very helpful = 4	3.30	0.78
Opinion on English	Very helpful = 1, very helpful = 4	3.11	0.93
Extracurricular	Attending extracurricular classes/activities: no=0 (reference); yes=1	46.61%	
Late for class	Late for class (never=1, always=4)	1.31	0.65
Skip class	Skip class (never=1, always=4)	1.10	0.43
Family economic status	Family economic status (very poor=1, very rich=5)	2.89	0.55
No. of sibling	Number of sibling	0.55	0.79
Mother's education	Years of mother's education	10.27	3.75
Father's education	Years of father's education	10.99	3.34
Parental strictness with exam	Parental strictness with respect to enforcing study for exams (not very strict=1, very strict=3)	2.42	0.57
Parental strictness with behaviour	Parental strictness with respect to ensuring good behaviour is maintained (not very strict=1, very strict=3)	2.27	0.62
Learning difficulties at sixth grade			
Chn6	Learning difficulty in Chinese at 6 <sup>th</sup> grade (very difficult=1, very easy=4)	3.23	0.81
Mat6	Learning difficulty in math at 6 <sup>th</sup> grade (very difficult=1, very easy=4)	2.93	1.01
Eng6	Learning difficulty in English at 6 <sup>th</sup> grade (very difficult=1, very easy=4)	2.79	1.10
<i>Class characteristics</i>			
Migscore6			
MigChn6	Average learning difficulty in Chinese at 6 <sup>th</sup> grade among migrant students (very difficult=1, very easy=4)	3.25	0.39
MigMat6	Average learning difficulty in math at 6 <sup>th</sup> grade among migrant students (very difficult=1, very easy=4)	2.93	0.55
MigEng6	Average learning difficulty in English at 6 <sup>th</sup> grade among migrant students (very difficult=1, very easy=4)	2.71	0.68
Average family economic status among migrant students	very difficult=1, very easy=4	2.91	0.33
Average father's education among migrant students	Years	10.55	2.19
Average mother's education among migrant students	Years	9.40	2.49
Proportion of migrant students		20.27%	
Proportion of male students in class		51.34%	
Students' mean age in class	Years	14.97	0.64
Average years of education of all student's parents	Year; average years of education of all student's parents	10.69	2.15
Average family economic status of all students' families	Average family economic status of all students' families (very poor=1, very rich=5)	3.05	0.56
ClsChn6	Average learning difficulty in Chinese at the 6 <sup>th</sup> grade for all students (scale: very difficult=1, very easy=4)	3.22	0.24
ClsMat6	Average learning difficulty in math at the 6 <sup>th</sup> grade for all students (scale: very difficult=1, very easy=4)	2.94	0.37
ClsEng6	Average learning difficulty in English at the 6 <sup>th</sup> grade for all students (scale: very difficult=1, very easy=4)	2.78	0.44
Class rank	The ordinal rank of class in academic records within the same grade (scale: worst=1, best=5)	3.45	1.03
Class size	Class size	40.35	14.77
Male head teacher	Gender of head teacher; reference: female	30.30	
Teaching experience of head teacher	Years of teaching experience of head teacher	17.29	7.00
Age of head teacher	Years	38.80	8.38
Education of head teacher	Highest qualification of head teacher		

Graduate diploma	Graduate diploma (reference group)	10.20%
Bachelor – continuing higher education	<i>chengren gaodeng jiaoyu</i>	41.84%
Bachelor – general (full-time) higher education	<i>putong gaodeng jiaoyu</i>	45.92%
Postgraduate qualification	Postgraduate qualification	2.04%

**Table A2 SUR estimates of peer effects: number of books at migrant students' homes**

	Chinese	Math	English
Number of books at migrants' homes	3.9477*** (2.72)	1.7384 (1.51)	0.9591 (1.25)
<i>N</i>	2520		
Log likelihood	-24978.899		

Notes: *t* statistics in brackets; \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; all specifications include control variables and school fixed effects; results are available from the authors.

**Table A3 Falsification tests**

	Chinese	Math	English
<b>Panel A</b>			
Proportion of migrant students	0.2323 (0.21)	-1.0186 (-0.89)	-0.2078 (-0.22)
<b>Panel B</b>			
Proportion of migrant students	-2.0962 (-0.28)	-8.6482 (-1.13)	-7.2783 (-0.94)
Average family economic status among migrant students	-0.5134 (-0.18)	1.5880 (0.54)	1.4597 (0.51)
Average father's education among migrant students	0.3831 (0.90)	0.3069 (0.82)	0.2876 (0.77)

Notes: *t* statistics in brackets; \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; all specifications include control variables and school fixed effects; results are available from the authors.

**Table A4 Fixed effects estimates of panel data for three subject scores among local students**

	Scores
Average learning difficulties at sixth grade among migrant students	1.1721*** (2.92)
<i>N</i>	8022
adj. <i>R</i> <sup>2</sup>	0.1632

Notes: *t* statistics in brackets; \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; all specifications include control variables and school fixed effects; results are available from the authors.